

UI IGEM TEAM 2016

MATHEMATICAL MODEL

$$\frac{dH_B(t)}{dt} = \lambda_H(t) + c_1 \sigma_{LB} H_L(t) - \sigma_{BL} H_B(t) (1 + \gamma I(t)) - \mu_H H_B(t)$$

$$\frac{dH_L(t)}{dt} = r(t) H_L(t) + \frac{1}{c_1} \sigma_{BL} H_B(t) (1 + \gamma I(t)) - \sigma_{LB} H_L(t) - k V_L(t) H_L(t) - \mu_H H_L(t)$$

$$\frac{dH_a(t)}{dt} = f k H_L(t) V_L(t) - \mu_a H_a(t)$$

$$\frac{dH_p(t)}{dt} = (1 - f) k V_L(t) H_L(t) + \alpha H_l(t) - \alpha' H_p(t) - \mu_p H_p(t) - \beta C_e(t) H_p(t)$$

$$\frac{dH_l(t)}{dt} = \alpha' H_p(t) - \alpha H_l(t) - \mu_l H_l(t)$$

$$\frac{dI(t)}{dt} = N_I \mu_a H_a(t) - \mu_I I(t)$$

$$\frac{dV_L(t)}{dt} = N_V H_p(t) + d_{BL} (V_B(t) - V_L(t)) - k V_L(t) H_L(t) - \mu_V V_L(t)$$

$$\frac{dV_B(t)}{dt} = d_{LB} (V_L(t) - V_B(t)) - \mu_V V_B(t)$$

$$\frac{dC_n(t)}{dt} = \lambda_c(t) - \varepsilon H_p(t) C_n(t) \left(\frac{H_L(t)}{H_L(t) + H_{1/2}} \right) - \mu_n C_n(t)$$

$$\frac{dC_e(t)}{dt} = \varepsilon H_p(t) C_n(t) \left(\frac{H_L(t)}{H_L(t) + H_{1/2}} \right) + \varepsilon H_p(t) C_e(t) + \rho C_e(t) - \omega C_e(t) - \mu_e C_e(t)$$

$$\frac{dC_m(t)}{dt} = \omega C_e(t) - \varepsilon H_p(t) C_e(t)$$

$H_B(0)$	$10^3 \text{ cells } \mu\text{L}^{-1}$
$H_L(0)$	$2.9 \times 10^5 \text{ cells } \mu\text{L}^{-1}$
$V_L(0)$	$1.4 \times 10^{-6} \text{ particles } \mu\text{L}^{-1}$
$C_n(0)$	$0.03 \text{ cells } \mu\text{L}^{-1}$
$\lambda_H(0)$	$4 \text{ cells } \mu\text{L}^{-1} \text{ day}^{-1}$
c_1	0.14
σ_{LB}	0.12 day^{-1}
σ_{BL}	5 day^{-1}
γ	$4 \times 10^{-3} \mu\text{L molecule}^{-1}$
μ_H	0.004 day^{-1}
r_{max}	0.055 day^{-1}

H_{max}	291164.7 cells μL^{-1}
k	2.4×10^{-5} $\mu\text{L molecule}^{-1} \text{ day}^{-1}$
f	0.95
μ_a	0.001 day^{-1}
α	0.03 day^{-1}
α'	0.01 day^{-1}
μ_p	0.5 day^{-1}
β	$10 \mu\text{L cell}^{-1} \text{ day}^{-1}$
μ_l	$5.25 \times 10^{-4} \text{ day}^{-1}$
N_I	15 molecules
μ_I	6.6 day^{-1}
N_V	$2000 \text{ molecules cell}^{-1} \text{ day}^{-1}$
d	0.1 day^{-1}
μ_V	23 day^{-1}
$\lambda_C(0)$	3.14×10^{-4} cells $\mu\text{L}^{-1} \text{ day}^{-1}$
ε	5×10^{-8} $\mu\text{L cell}^{-1} \text{ day}^{-1}$
$H_{1/2}$	1.45×10^5 cells μL^{-1}
μ_n	0.01 day^{-1}
ρ	2.9 day^{-1}
ω	0.009 day^{-1}
μ_e	0.57 day^{-1}

$$\lambda_H(t) = \lambda_H(0)^{(t/365)}$$

$$\lambda_C(t) = \lambda_C(0)^{(t/365)}$$

$$r(t) = r_{max} \left(1 - H_{tot}(t) / H_{max} \right) = r_{max} \left(1 - \frac{H_L(t) + H_a(t) + H_p(t) + H_l(t)}{H_{max}} \right)$$